# OPERATING INSTRUCTIONS

## MODEL TTS 28

### PORTABLE STATION TEST SET

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## 1.0 GENERAL

1.01 The Model TTS 28 is a general purpose portable station test set. It provides the functions of a level measuring set which can be operated either on a terminated or bridged basis in a 900-ohm circuit and of the voltage, current and resistance measuring facilities provided in a "multimeter" or "analyzer". In addition, it provides a through connection from its input terminals to a second set of terminals to which a subscriber set may be connected.

1.02 The different functions which the Model TTS 28 provides are selected by means of a 17-position rotary switch. To use the level measuring and AC voltmeter functions, the power switch must be moved to the ON position.

1.03 The set contains a transistor amplifier for use on the level measuring and AC voltage ranges. The batteries to operate this amplifier and those needed to energize the resistance measuring circuits are located inside in the instrument case.

1.04 The set measures 6" x 7" x 3" deep without, and 6" x 7" x 4 3/4" deep with the detachable cover in place. These dimensions exclude the carrying handle and rubber feet. The set weighs four pounds. Closing the cover will restore the power switch of the transistor amplifier battery to the off position. The battery used for the transistor amplifier is a Burgess P6M or equivalent. Two standard "penlight" flashlight cells provide power for the resistance measuring circuit. Space is provided in the cover for carrying necessary test leads.

1.05 The set should be used in a vertical position.

1.06 Always be certain the power switch is off when the meter is not in use to prevent excessive drain of the batteries.

## 2.0 PERFORMANCE

2.01 The meter face carries the following scales and requires the power switch to be in the position indicated on the following table:

| Scale | Range | Color | Power Switch |
|---|---|---|---|
| DB | +5 to -15 | Black | On |
| DC | 0 to 150 | Red | Off |
| | 0 to 30 | Red | Off |
| AC | 0 to 150 | Black | On |
| OHMS | 0 to 5K | Green | Off |
| BATT TEST | | Green Arc | On |

In addition it carries the following notation:

0 dbm is 1 mw 900 ohms

Level Measuring Circuits

2.02 For operation on a 900-ohm terminated basis two level ranges are provided:

+5 dbm to -15 dbm
-5 dbm to -25 dbm

2.03 The AC impedance of the Model TTS 28 is 900 ohms ±1% at 1000 cps. In the "terminated" position, a 935 ohms, 3 watt resistor is connected directly across the input terminals to provide a DC holding circuit.

2.04 For operation on a "bridging" basis, three level ranges are provided:

+15 dbm to -5 dbm
+5 dbm to -15 dbm
-5 dbm to -25 dbm

2.05 The bridging impedance of the TTS 28 is in excess of 15,000 ohms for frequencies from 625 to 3,500 cps.

2.06 The level measuring circuits incorporate a high pass filter. As referred to 1,000 cps, the response of the Model TTS 28 is within ±0.3 db from 500 cps to 20,000 cps. At 60 cps the response is down by at least 25 db and at 180 cps by at least 6 db. The level measuring section of the Model TTS 28 is usable to approximately 500 KC, but individual calibration at frequencies above 20 KC is recommended.

2.07 The effects of temperature, battery voltage, attenuator position and scale nonlinearities are as follows:

Reference Point: 0 dbm on +5 db to -15 db scale; 1,000 cps; 70°F

Battery Voltage: 6 to 9 volts = ±0.1 db

Attenuator: +10, 0, -10, = ±0.1 db

Meter Accuracy: 1% of full scale

Temperature: 40°to 120°F = -0.3 to +0.1 db

Through Connections

2.08 Two positions on the rotary switch provide a through connection for the input terminal (marked + and -) to the terminals marked TEL SET. In the DIAL position the meter is removed from the circuit, in the second position a 0-150 ma DC range is provided to measure the current in the TEL SET. A 10-ohm meter shunt is inserted between the two pairs of terminals in these positions.

Multimeter Ranges

2.09 AC voltage measurements are provided in two ranges, namely:

0-15 volts
0-150 volts

The accuracy of these meter ranges is ±3% full scale. The frequency response on the AC scales is within ±3% from 50-20,000 cps. The meter impedance is in excess of 15,000 ohms per volt.

2.10 DC voltage measurements are provided in three ranges, namely:

0-1.5 volts
0- 30 volts
0-150 volts

The accuracy of these ranges is ±3% of full scale and the meter impedance is 20,000 ohms per volt.

2.11 DC current measurements are provided in two ranges, namely:

0-30 ma
0-150 ma

The accuracy of these ranges is ±3% of full scale. When used to measure DC currents a resistance of 10 ohms appears between the input (+ and -) terminals.

2.12 Resistance measurements are provided in two ranges, namely:

0-5,000 ohms
0-500,000 ohms

The center position of the meter pointer corresponds to a reading of approximately 200 ohms on the lower and 20,000 ohms on the higher scale.

Batteries

2.13 A Burgess P6M or equivalent 9-volt battery is used for the amplifier. For intermittent operation, the normal life of the amplifier battery is over 200 hours. Two "penlight" flashlight batteries are used for the resistance measuring circuit. They are Burgess #Z Type AA (1.5 volts) or equivalent.

2.14 For battery tests, see paragraph 5.08.

Meter Short

2.15 In the METER SHORT position of the rotary switch, the meter is shorted. The selector switch should be turned to this position to provide electrical damping for the meter when it is being transported or when it is not in use. In this position the input terminals are open.

3.0 DESCRIPTION

3.01 The Model TTS 28 contains a transistorized amplifier designed to drive the meter for all level measurements and AC voltage measurements. In addition, it provides a through connection from the input (+ and -) terminals to the terminals marked TEL SET and it contains DC voltage, current, and resistance measuring provisions. The front panel view of this set is shown in Fig. 1.

Level Measuring Circuit

3.02 In all level measuring positions of the selector switch a high impedance, high pass filter is inserted between the input terminals and the amplifier input. The filter feeds a voltage divider type of attenuator. The switch arm which selects the tap on this attenuator is connected to the input of the transistor amplifier. This circuit arrangement is shown in the overall schematic, Fig. 2.

3.03 The amplifier is a conventional transistor amplifier in which the rectifier bridge supplying the meter is inserted in the feedback path. Specially selected components as well as the use of negative feedback provide stability of effective gain with variations in temperature and battery voltage. The basic circuit of the high pass filter attenuator, the amplifier, and the meter is shown in Fig. 3. The amplifier-rectifier combination is designed to deliver approximately 0.5 ma in the meter circuit. A 50µa meter is required to provide the necessary 20,000 ohms per volt DC sensitivity. Therefore, the meter is shunted when it is used in the amplifier output circuit.

3.04 The amplifier has sufficient gain to provide a 0 dbm meter reading with an input signal of -5 dbm. The meter scale is calibrated from +5 to -15 db. As a result, levels of 25 dbm can

be read in the most sensitive position of the attenuator.

3.05 In the "bridging" position, the filter input is directly connected to the input terminals; in the "terminating" position, the filter input is shunted by a resistance to provide an input impedance of 900 ohms at 1000 cps. As this resistance is connected directly between the input terminals it also provides a DC holding circuit for the "terminated" level measuring application.

AC Measurements

3.06 For AC voltage measurements, the amplifier input is connected to the input through a suitable voltage divider. In this position the frequency response is ±3%, from 50 cps to 20,000 cps.

DC Multimeter Functions

3.07 The DC multimeter functions are conventional in design and reference to Fig. 2 should make the circuits self-explanatory.

Through Connections

3.08 Two positions for through connections between the input terminals and the TEL SET terminals are provided on the rotary switch. One position is marked DIAL. In this position the meter is disconnected from the circuit so that it will not be affected by dial pulses and similar transients. If the power switch is moved to the ON position while the selector switch is in the DIAL position, the meter will indicate the condition of the amplifier battery.

3.09 The second "through" position inserts a 0-150 ma meter between the input terminals and the TEL SET terminals. This provides a measurement of the input current through the equipment attached to the TEL SET terminals.

Meter Short Position

3.10 In the METER SHORT position, a short circuit is placed across the meter. This position should be used when the meter is being transported or when it is not in use. No circuit is connected to the input terminals in this position of the selector switch.

4.0 CALIBRATION

4.01 For Resistance Tests

a. Set the FUNCTION switch to the desired OHMS position.

b. Connect the + and - terminals on the set together through the test leads or by means of a wire or screwdriver. The meter should read 0.

.948687V = 0 D.B. at 900 Ω



c. If the meter does not read zero, set the OHMS ADJ control for a zero reading. If it is not possible to reach zero, the batteries used for the OHMS circuit should be replaced.

4.02 For DBM Operation

Normally there are no calibration adjustments required to calibrate the amplifier. A factory adjustment has been made to assure a reading of 0 dbm at 900 ohms input impedance. If there is any question on the accuracy of the dbm readings, it may be checked as follows:

a. With no input signal, the meter should read zero. If this is off, reset the mechanical zero adjustment screw. This adjustment should be made with the meter in the vertical position.

b. Connect the output terminals of an accurate 900-ohm source of 1,000 cps 1 mw sine wave power to the + and - terminals of the Model TTS 28.

c. Set the FUNCTION switch to the DBM 900 OHM TERM - 0 (dbm) position.

d. Switch the DB, AC SCALES AND BATT TEST switch to ON. The meter should now read 0 within the limits specified under Performance.

e. Only if the meter reads out of limits should the panel of the test set be removed from the case. The control on the component board designated as R23 on the circuit diagram can then be reset to give 0 on the meter.

5.0 OPERATION

5.01 Initial Steps

a. Unlatch and open cover. The cover can be detached from the case by sliding the cover up to the handle end of the case. When measurements are completed, it is recommended that the cover be attached and closed, as a bracket on the cover will turn off the power switch when the cover is closed. This avoids leaving the set on when not in use and can substantially prolong battery life.

b. Turn the switch marked DB, AC SCALES AND BATT TEST to ON if dbm or AC voltage measurements are to be made.

c. Connect the line or circuit to be tested to + and - terminals. If the test leads are to be used, connect them to these terminals.

d. When a telephone set is to be used, connect it to the TEL SET terminals.

The instrument is now set up to receive signals, dial through and talk, or to use the test leads.

5.02 To Make Level Measurements

a. On a 900-ohm termination basis-

1. If it is necessary to connect through to a reference tone generator or call a test board, set the FUNCTION switch to TEL SET - DIAL and call the desired number by using the telephone set connected to the TEL SET terminals. If the power switch has been moved to the ON position, this position of the FUNCTION switch will cause the meter to read the condition of the battery as described in paragraph 5.08.

2. When a tone is received, turn the FUNCTION switch to one of the two DBM 900 OHM TERM positions which will give a meter reading on the upper part of the scale where possible.

b. On a "bridging" basis-

1. Turn the FUNCTION switch to the DBM BRDG position which will give a meter reading on the upper part of the scale where possible.

5.03 To Measure Line Current Through the Instrument Connected to TEL SET Terminals

a. Follow step a.1 above.

b. Set FUNCTION switch to TEL SET-150 MA position and read the current on the red DC 0 to 150 scale.

5.04 To Measure AC Voltage

a. Set FUNCTION switch to the VAC position which will give a convenient meter reading.

b. Connect the test leads to the circuit under test.

c. Read the voltage on the black AC, 0 to 150 scale.

5.05 To Measure DC Voltage

a. Set FUNCTION switch to the VDC position which will give a convenient meter reading.

b. Connect the test leads to the circuit under test.

c. Read the voltage on the appropriate red DC scale on the meter.

5.06 To Measure DC Current Up to 150 ma

a. Set FUNCTION switch to the MA DC position which will give a convenient meter reading.

b. Connect the circuit to be tested to the + and - terminals.

c. Read the current on the appropriate red DC scale on the meter.

5.07 To Measure Resistance

a. Set the FUNCTION switch to the OHMS position which will provide the desired resistance range.

b. Set the OHMS ADJ control in accordance with the calibration procedure outlined in paragraph 4.01.

c. Connect the test leads to the circuit or component under test.

d. Read the resistance on the green scale on the meter and multiply by the X1 or X100 factor selected with the FUNCTION switch.

5.08 Battery Test

a. When the DC, AC SCALES AND BATT TEST switch is in the ON position and the FUNCTION switch is set at TEL SET-DIAL, the meter will read the condition of the amplifier battery. If the meter reads within the area of the heavy green arc, the battery is good; if it reads below the arc, the battery should be replaced.

b. The OHMS scale batteries are good if the OHMS ADJ control can be set in accordance with the OHMS calibration procedure. If the adjustment cannot be made as outlined, the batteries should be replaced.

5.09 Transportation

a. When measurements are completed, the FUNCTION switch should be turned to METER SHORT and the lid closed. This will provide a short circuit across the meter during transport. Furthermore, battery life will be prolonged as closing the lid turns off the battery power to the amplifier if manual operation of switch is overlooked.

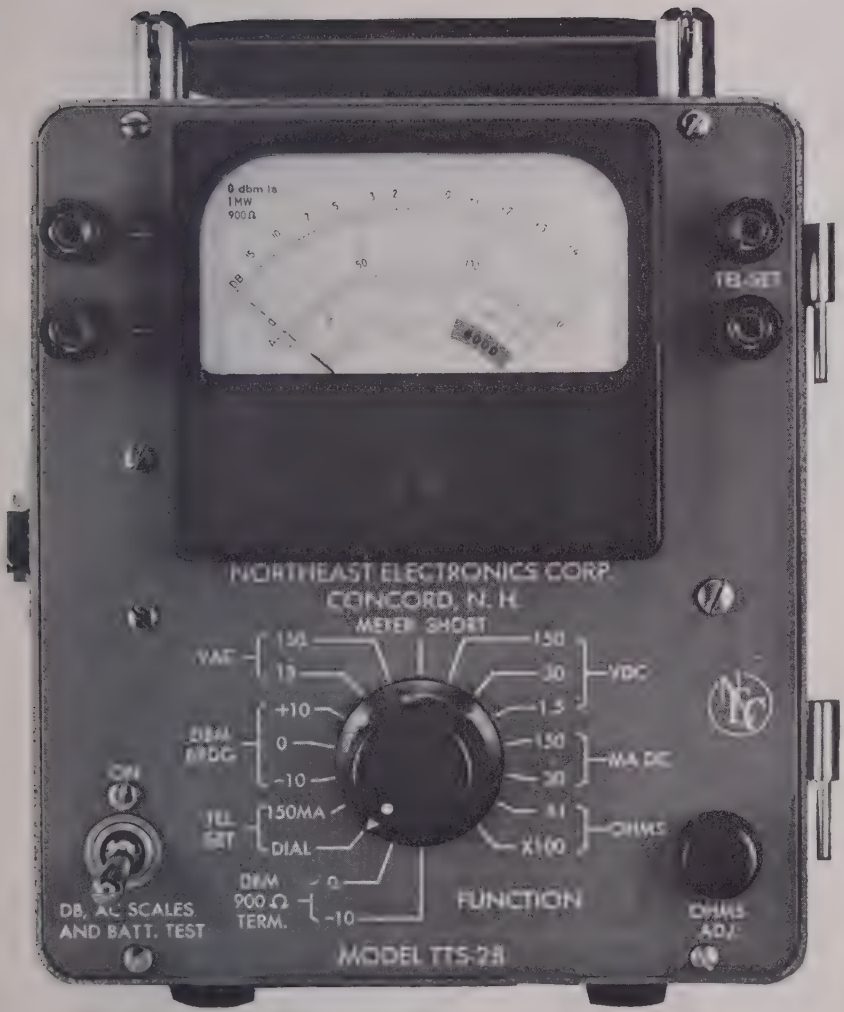
## 6.0 MAINTENANCE

6.01 Normally the set should need no maintenance other than replacing worn out batteries and an occasional check on the calibration of the dbm meter operation.

6.02 The amplifier battery should be tested in accordance with paragraph 5.08 If the test shows a worn out battery, replace it with a Burgess P6M 9-volt transistor battery or equivalent.

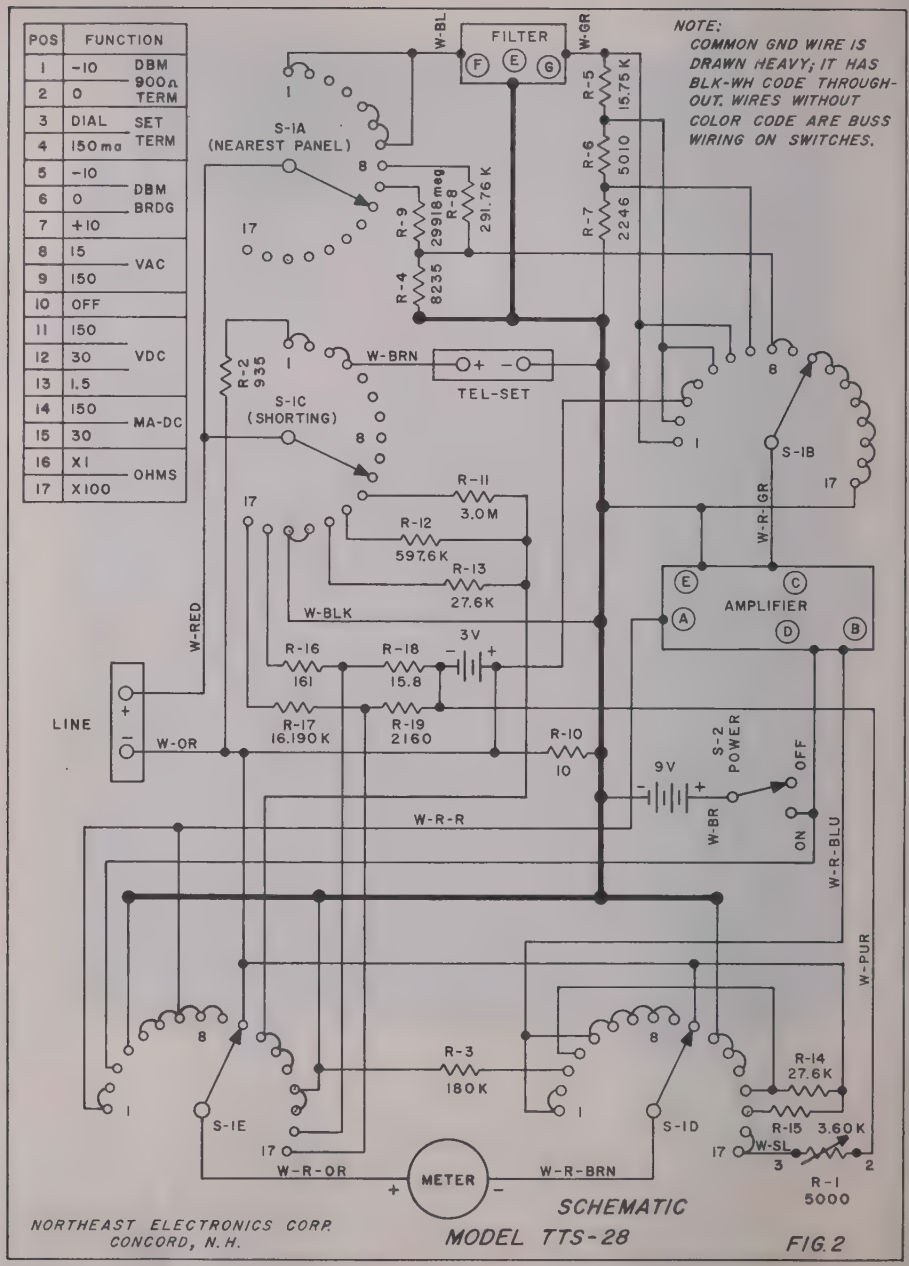
6.03 The batteries used in the OHMS circuit should be tested in accordance with paragraph 4.01. If the batteries are defective, they should be replaced with two 1 1/2-volt Burgess No Z, size AA batteries or equivalent

6.04 The procedure for checking the calibration of the dbm meter operation is outlined in paragraph 4.02.




FRONT PANEL

Fig. 1


POS
FUNCTION
1 -10 DBM
2 0 900Ω TERM
3 DIAL
4 150 ma SET TERM
5 -10
6 0 DBM BRDG
7 +10
8 15
9 150 VAC
10 OFF
11 150
12 30 VDC
13 1.5
14 150
15 30 MA-DC
16 X1
17 X100 OHMS
NOTE:
COMMON GND WIRE IS DRAWN HEAVY; IT HAS BLK-WH CODE THROUGHOUT. WIRES WITHOUT COLOR CODE ARE BUSS WIRING ON SWITCHES.
FILTER
W-BL
W-GR
R-5 15.75K
R-6 5010
R-7 2246
R-8 291.76 K
R-9 29918 meg
R-4 8235
S-1A (NEAREST PANEL)
S-1C (SHORTING)
R-2 935
W-BRN
TEL-SET
S-1B
W-R-GR
R-11 3.0M
R-12 597.6K
R-13 27.6K
AMPLIFIER
W-BLK
W-RED
3V
R-16 161
R-18 15.8
R-17 16.190 K
R-19 2160
LINE
W-OR
R-10 10
9V
S-2 POWER
OFF
ON
W-BR
W-R-R
W-R-BLU
W-PUR
R-3 180K
R-14 27.6K
R-15 3.60K
W-SL
R-1 5000
S-1E
S-1D
W-R-OR
W-R-BRN
METER
SCHEMATIC
MODEL TTS-28
FIG. 2
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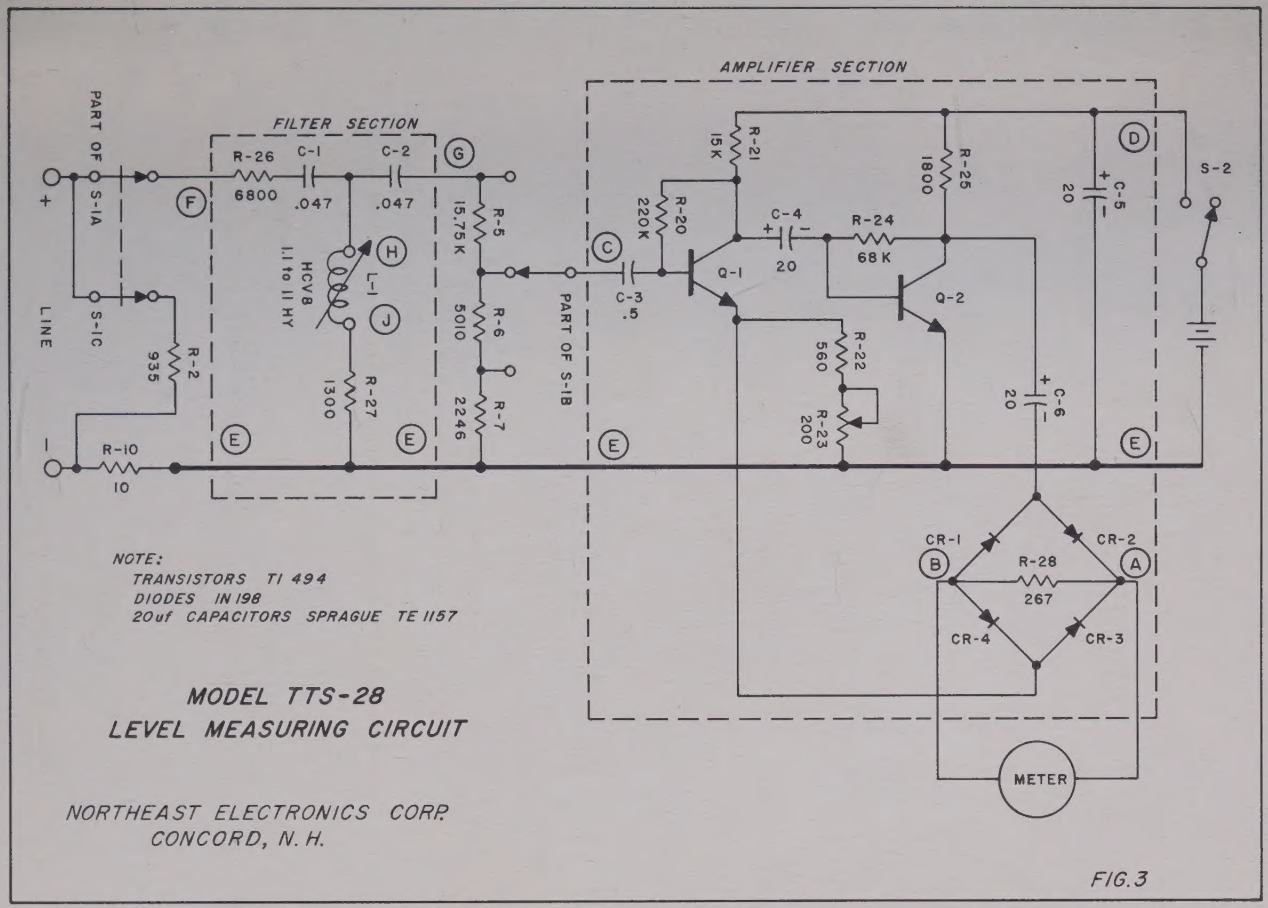


NOTE:
TRANSISTORS TI 494
DIODES IN 198
20uf CAPACITORS SPRAGUE TE 1157

## MODEL TTS-28
## LEVEL MEASURING CIRCUIT

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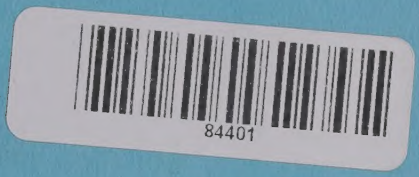
FIG. 3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